

AD-A192 618

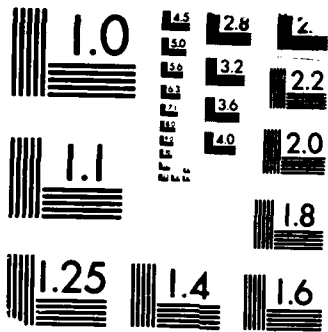
WHEN THE BALLOON GOES UP: BARRAGE BALLOONS FOR  
LOW-LEVEL AIR DEFENSE(U) AIR COMMAND AND STAFF COLL  
MAXWELL AFB AL F J HILLSON APR 88 ACSC-88-1225

1/1

UNCLASSIFIED

F/G 1/3. 11 NL





AD-A192 618



# AIR COMMAND AND STAFF COLLEGE

## STUDENT REPORT

WHEN THE BALLOON GOES UP:  
BARRAGE BALLOONS  
FOR LOW-LEVEL AIR DEFENSE

MAJOR FRANKLIN J. HILLSON 88-1225  
"insights into tomorrow"

DTIC  
ELECTE  
MAY 11 1988  
S D  
E

This document has been approved  
for public release and sale in  
distribution is unlimited.

88 5 10 314

# DISCLAIMER

The views and conclusions expressed in this document are those of the author. They are not intended and should not be thought to represent official ideas, attitudes, or policies of any agency of the United States Government. The author has not had special access to official information or ideas and has employed only open-source material available to any writer on this subject.

This document is the property of the United States Government. It is available for distribution to the general public. A loan copy of the document may be obtained from the Air University Interlibrary Loan Service (AUL/LDEX, Maxwell AFB, Alabama, 36112-5564) or the Defense Technical Information Center. Request must include the author's name and complete title of the study.

This document may be reproduced for use in other research reports or educational pursuits contingent upon the following stipulations:

- Reproduction rights do not extend to any copyrighted material that may be contained in the research report.

- All reproduced copies must contain the following credit line: "Reprinted by permission of the Air Command and Staff College."

- All reproduced copies must contain the name(s) of the report's author(s).

- If format modification is necessary to better serve the user's needs, adjustments may be made to this report--this authorization does not extend to copyrighted information or material. The following statement must accompany the modified document: "Adapted from Air Command and Staff College Research Report \_\_\_\_\_ (number) entitled \_\_\_\_\_ (title) \_\_\_\_\_ by \_\_\_\_\_ (author)."

- This notice must be included with any reproduced or adapted portions of this document.



**REPORT NUMBER**

88-1225

**TITLE**

WHEN THE BALLOON GOES UP: BARRAGE BALLOONS FOR  
LOW-LEVEL AIR DEFENSE

**AUTHOR(S)**

MAJOR FRANKLIN J. HILLSON, USAF

**FACULTY ADVISOR**

MAJOR ALLAN W. HOWEY, ACSC/EDJ

**SPONSOR**

DR. FREDERICK J. SHAW, USAFHRC/RI

Submitted to the faculty in partial fulfillment of  
requirements for graduation.

**AIR COMMAND AND STAFF COLLEGE  
AIR UNIVERSITY  
MAXWELL AFB, AL 36112-5542**

This document has been approved  
for public release and sale; its  
distribution is unlimited.

A192 618

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS N/A		
2a. SECURITY CLASSIFICATION AUTHORITY N/A			3. DISTRIBUTION / AVAILABILITY OF REPORT STATEMENT "A" Approved for public release; Distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 88-1225			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION ACSC/EDC		6b. OFFICE SYMBOL (If applicable)		7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State, and ZIP Code) Maxwell AFB, AL 36112-5542			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
11. TITLE (Include Security Classification) WHEN THE BALLOON GOES UP: BARRAGE BALLOONS FOR LOW-LEVEL AIR DEFENSE					
12. PERSONAL AUTHOR(S) HILLSON, FRANKLIN J., MAJOR, USAF					
13a. TYPE OF REPORT		13b. TIME COVERED FROM _____ TO _____		14. DATE OF REPORT (Year, Month, Day) 1988 April	
				15. PAGE COUNT 29	
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)  Barrage balloons were effectively used to assist in countering low-level air attacks in both World War I and II. Great Britain was convinced of its value and liberally employed aerial barrages throughout both conflicts. The United States followed suit with a large barrage balloon program during World War II. The balloons are gone, but the low-level threat still poses a problem. The barrage balloon can still provide effective, force-enhancing protection against this form of attack. Because of their point defense capability, barrage balloons are ideally suited for air base defense.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL ACSC/EDC Maxwell AFB, Al 36112-5542			22b. TELEPHONE (Include Area Code) (205) 293-2867		22c. OFFICE SYMBOL

---

## PREFACE

---

Subject to clearance, this manuscript will be submitted to Air Power Journal for consideration.

This article describes the effectiveness of the barrage balloon in countering low-level air attacks during World War I and II. Valued by the British, aerial barriers protected their vital installations--cities, harbors, factories--against low-flying aircraft. Spurred on by Pearl Harbor and by the British successes with balloons, the United States initiated its own extensive barrage balloon program to protect important areas on the West Coast, Hawaii, and Panama. Barrage balloons all but disappeared after the war, but the threat from fast, low-flying aircraft still remains. Aerial barrages still offer a deterrent to this type of attack and can be profitably employed on the modern battlefield to protect NATO's vital airfields.

I gratefully acknowledge the unending support of my indefatigable wife, Christina. She has made this idea a reality as she does with all my projects, both business and personal.

<b>Accession For</b>	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



---

## ABOUT THE AUTHOR

---

Major Franklin J. Hillson hails from Philadelphia, Pennsylvania, and is a career Air Force officer. He graduated cum laude from the Virginia Military Institute in 1975 with a Bachelor of Arts Degree in English. Major Hillson started active duty in August 1975 at Tyndall AFB, Florida, as an air weapons controller trainee.

Following initial controller training, he spent one year at Hancock Field, New York, controlling fighters (1975-76) and then had a one year remote tour in the Canadian Arctic on the Distant Early Warning (DEW) Line (1976-77). His next assignment brought him south to Ft. Lee Air Station, Virginia, where he performed various air weapons controller duties from 1978-1980. His tour in Virginia was climaxed by being a member of the championship "Top Scope" control team during the 1978 World-Wide Air Weapons Meet at Tyndall AFB.

In 1980 the major received an Air Force Institute of Technology assignment to attend the College of William and Mary for a Master of Arts Degree in English. This year of study prepared him for his follow-on tour as a member of the English Department at the USAF Academy (1981-84). There he won the coveted William C. Clements award as the best English instructor for the 1982-83 academic year.

After faculty duty Major Hillson spent three years at Sembach Air Base, Germany (1984-87). He performed basic controller duties the first year but was later hand-picked to be the executive officer for the Commander of the 601st Tactical Control Wing.

A 1983 graduate of Squadron Officer School and a 1985 graduate of the Air Weapons Director Staff Officer Course, Major Hillson is currently a member of the Air Command & Staff College resident Class of 1988. His decorations include the Meritorious Service Medal and the Air Force Commendation Medal with two Oak Leaf Clusters. Major Hillson's wife, Christina, is a native of Maryland. They have two children. Off duty, the major enjoys literature, military history, and playing soccer.

---

## TABLE OF CONTENTS

---

Preface.....	iii
About the Author.....	iv
Table of Contents.....	v
Executive Summary.....	vi
INTRODUCTION.....	1
CHAPTER ONE -- THE LOW-LEVEL THREAT AND SAM LIMITATIONS.....	1
CHAPTER TWO -- BARRAGE BALLOON USACE IN WORLD WAR I AND BRITISH EMPLOYMENT DURING WORLD WAR II.....	4
CHAPTER THREE -- BARRAGE BALLOON DEVELOPMENT AND EMPLOYMENT IN THE UNITED STATES (1923-WWII).....	9
CHAPTER FOUR -- BARRAGE BALLOONS: THEIR APPLICABILITY TODAY.....	13
CONCLUSION.....	17
BIBLIOGRAPHY.....	19



## EXECUTIVE SUMMARY

Part of our College mission is distribution of the students' problem solving products to DOD sponsors and other interested agencies to enhance insight into contemporary, defense related issues. While the College has accepted this product as meeting academic requirements for graduation, the views and opinions expressed or implied are solely those of the author and should not be construed as carrying official sanction.

"insights into tomorrow"

### REPORT NUMBER

88-1225

### AUTHOR(S)

MAJOR FRANKLIN J. HILLSON

### TITLE

WHEN THE BALLOON GOES UP: BARRAGE BALLOONS FOR LOW-LEVEL AIR DEFENSE

I. Purpose: To analyze the use of barrage balloons during World War I and II and to determine if barrage balloons have any utility today in protecting NATO's airfields against low-level air attack.

II. Problem: As demonstrated in warfare, the high-speed, low-level air attack continues to be difficult to combat. The experiences of both the British and the Argentines in the Falkland Islands War offer a fairly recent example of fast, ultra low-flying aircraft negating air defenses and successfully attacking their targets. Something else is needed to help enhance existing air defense weapons while deterring this form of attack. Barrage balloons provide an effective solution.

III. Data: Looking for a way to help foil low-level air attacks during World War I, several combatants employed the barrage balloon. The British especially embraced the barrage balloon concept and employed aerial barrages against German Gotha bomber attacks on London. Though basically a passive weapon, the balloon was effective in limiting the operational arena of the bombers (in both direction and altitude),

## **CONTINUED**

thus making the acquisition of the bomber easier for defending guns and fighters. World War II provided another opportunity for the British to employ their balloons--this time against a more numerous, more technologically advanced air force. Performing mainly in the low-altitude area, balloons did excellent work in thwarting numerous low-flying attacks on important installations. Balloons were considered an important component of the British air defense system and were integrated as such. The United States also had a well developed barrage balloon program, seeing these aerial barriers as a significant deterrent to low-level attack on the Pacific Coast and other vital areas. Barrage balloons disappeared after World War II as newer, more sophisticated air defense weapons were introduced. The low-level threat, however, is still a problem, and Soviet air tactics entail a high-speed, ultra low-level air attack with NATO's air bases as a priority target.

IV. Conclusions: The combat-proven value of barrage balloons, along with their simple design and important purpose, makes the barrage balloon an ideal weapon to help defend NATO's airfields against low-level attack.

V. Recommendations: That barrage balloons be considered for use in protecting the West's vital air bases against low-level air attack and that Air Force leaders keep reviewing history for lessons applicable for the future.

## Introduction

The United States and its NATO allies are at a distinct disadvantage when it comes to conventional war in Europe: They lack numbers. They are outnumbered in the air and on the ground. Yes, the debate over quantity versus quality lingers on, but the vast amounts of Soviet aircraft and armor present a major dilemma to the West. Specifically, in the air NATO faces a large number of Warsaw Pact attack aircraft whose primary objective is, no doubt, the airfield--a target as important to destroy to the East as it is to defend to the West. The West's potent ground-based antiaircraft system--consisting mainly of surface-to-air missiles--can be countered by jamming and especially by low-level flight. In fact, a high-speed, low-level attack at 100 feet or less makes NATO airfields and other vital targets terribly vulnerable.(16:40) If the West is to improve its defenses against low-level air assault, it needs another element of the air defense team, something that can enhance current antiaircraft weapons while providing an extra measure of protection to vital areas. That something is the barrage balloon.

Many remember or have seen pictures of barrage balloons floating majestically in the skies over England in mock peacefulness during World War II. These large airborne barriers protected vital installations--in both Great Britain and in the United States--against low-level air attack. They complemented the existing air defense system and particularly in England proved their worth on numerous occasions in helping to thwart low-flying enemy aircraft. Despite advances in antiaircraft technology, the low-level threat still exists. This paper will first examine the current low-level threat and the limitations of surface-to-air missiles (SAM).(16:40-41) Next, it will look at history to trace barrage balloon usage in World War I and British employment of this weapon during World War II. Third, it will examine the barrage balloon program in the United States from the early twenties and into the war years. Finally, it will discuss the applicability of using barrage balloons today to help protect a vital NATO asset: the airfield.(16:--)

## Chapter One

### THE LOW-LEVEL THREAT AND SAM LIMITATIONS

Technology has allowed aircraft to fly higher and faster, but it has also provided them the means to fly lower which is perhaps

the more advantageous trait when it comes to fighting on the modern battlefield. This chapter examines the low-level threat using the Falkland Islands War to illustrate both the effectiveness of low-level attacks and the limitations of SAMs.

Radar, antiaircraft artillery (AAA), and particularly SAMs make modern air defenses extremely formidable, but these systems have a very definite area of vulnerability which will be exploited by enemy aircraft. That window of weakness is the ultra low-level attack. The deadliness of SAMs and other antiaircraft systems at higher altitudes makes the use of the low-level arena a major tactic of both NATO and the Warsaw Pact. It helps negate SAMs and has the added bonus of decreasing response time while increasing surprise. For example, a MIG-27 flying extremely fast and low can make it from Berlin to Bitburg Air Base in only 30 minutes.(9:79) Fast, low-flying strike aircraft present a serious problem to our air defenses, especially when one considers the sheer numbers of attack aircraft possessed by the Warsaw Pact. Squadron Leader P. D. John of the Royal Air Force elaborates on the low-level threat in his excellent article "Aerial Barrages to Enhance Airfield Defences":

Over the past 20 years, tactical strike/attack aircraft have been designed by the Soviet Union and by western nations to deliver weapons from low-level, where they can achieve surprise and pose most problems to defensive systems. The speed at which such aircraft operate has been steadily increased, as has their capability to fly and drop weapons from progressively lower levels: speeds of 400 to 500 knots at a height of 100 feet or less [emphasis added] are now regarded as standard operating parameters. Facing NATO's Central Region, the WP [Warsaw Pact] deploys specialised ground attack squadrons with the range to tackle targets in the UK as well as continental Europe. Flogger D and Fencer are operational in large numbers, and the latter carries terrain-avoidance radar to improve its ultra-low-level capability. These third-generation aircraft. . . pose a considerable threat to the survivability of NATO air forces during a conventional war.(16:40)

The Falkland Islands War offered a solid example of the effectiveness of high-speed, low-altitude tactics in negating SAMs. At Port Stanley and at the nearby airfield, the Argentineans concentrated the bulk of their ground-based antiaircraft weapons. Potentially very dangerous, these defenses consisted of a Roland missile unit, three units of Tigercat missiles, and a good sprinkling of Blowpipe shoulder-launched weapons, as well as a collection of 20mm and 35mm rapid-fire guns.(3:30) The area seemed fairly well protected, but the British still believed they could successfully attack this target even though an earlier Vulcan bomber raid had robbed them of any chance of strategic surprise.(3:55) Travelling at 550-600 knots, the Sea Harriers approached ultra low

at 50 feet above the ocean.(3:56, 58) The mission was a complete success with no losses to the attackers. During the course of the war, the British flew even lower to break radar lock once their radar warning receiver indicated SAM activation.(12:27, 28) Throughout the entire war, SAMs accounted for only two British aircraft. (3:249-250)

The low, fast tactics so successfully employed by the British were also impressively used by the Argentines. They flew "so low en route to their targets that salt water drops evaporated on their windshields, obscuring vision." (11:45) Against ground targets the Argentine pilots used the same tactics, hugging the contours of the land to shield them against early warning systems and SAMs. In Lessons of the South Atlantic War, General Sir Frank King stated:

With one exception, all aircraft which attacked ground forces flew at less than 100 feet, using the ground contours. They were seldom exposed to surveillance radars until at a maximum of four kilometres range and there was often very little warning of their approach. The problem was exacerbated by bad weather, low cloud, mist, [and] low light levels in valley bottoms for the last two to three hours of daylight. . . .(25:88)

The Argentine Air Force scored some noticeable victories during the war despite the long 400 mile flight from their bases on the mainland, lack of coordination, defective bombs, and a relatively strong British air defense system. The Blowpipe shoulder-launched guided missile made up a good part of British air defenses and deserves a brief word.

Many see the man-portable SAM as the answer to the low-level threat. Indeed, this light-weight, low-cost weapon offers flexibility of use in battle and availability in large numbers. "Their main missions," according to Christian Poehhacker, a Defence International Update writer, "are to ensure the anti-aircraft protection of units and sensitive locations, and to create above the battle zone an airspace so insecure that the chances for survival of low and very low flying aircraft will be extremely small."(17:10) Unfortunately, these weapons may be overrated for several reasons. First, the user must "eyeball" his target and then align it in his optical sight. Visual conditions, then, are extremely important in acquiring the target. Firing time is another factor. A high-speed, low-level aircraft usually gives the Blowpipe operator a maximum of 20 seconds to locate, acquire, and engage the target. (25:89) At 500 knots the aircraft travels over three miles in those 20 seconds which may put it out of range when ready to fire. The last disadvantage concerns the small 1-kilogram warhead, the standard weight for most man-portable SAMs. According to Christian Poehhacker:

a 1 kg warhead is not powerful enough to obtain a destructive effect when the missile does not actually hit the target. . . .

Experience in recent conflicts has revealed that a large percentage of aircraft hit by missile warheads of about 1 kg have been able to regain their bases. For example, a Super Etendard was able to return to its aircraft carrier after being hit by an SA-7 while supporting French troops in Beirut in 1984. Another lesson with the same SAM-type was learned in the Yom Kippur War, when almost half of the Israeli A-4 Skyhawks hit by SA-7s returned to base.(17:11)

Even though the Blowpipe contains a 2-kilogram warhead, a combination of the other factors still caused the British Blowpipe to have a relatively poor performance during the Falkland War. Of the 100 Blowpipe missiles launched at the enemy, only nine were kills.(11:91) Those nine successful strikes claimed only slow, low-flying Pucara ground attack aircraft and helicopters.(17:12)

Air defense weapons will improve--the excellent Stinger is proof of that--but there is no doubt that low-flying aircraft continue to be extremely difficult to combat. The experiences in the Falkland Islands attest to that fact. Interestingly enough, the British had a similar problem with fast, low-flying enemy aircraft during World War II, but they countered this threat by employing a wonderfully simple weapon: the barrage balloon.

## Chapter Two

### BARRAGE BALLOON USAGE IN WORLD WAR I AND BRITISH EMPLOYMENT IN WORLD WAR II

In order to appreciate the extent to which barrage balloons were employed by the English during World War II, it is necessary to look at the rudimentary aerial barrages used by several countries during the Great War. This chapter will first discuss barrage balloon use in Europe during World War I. Then, it will look at British barrage balloon employment during the Second World War, focusing on the balloons' "combat performance" during that conflict.

The idea of using an aerial barrier against enemy aircraft probably originated with the Germans, but it was the British who really took this concept to heart and vigorously applied it on a wide scale. The barrage balloon was simply a bag of lighter-than-air gas attached to a steel cable anchored to the ground. The balloon could be raised or lowered via a winch to a desired altitude. Its purpose was ingenious: to deny low-level airspace to enemy aircraft. This simple mission provided three major benefits. It

forced aircraft to higher altitudes, thereby decreasing surprise and bombing accuracy; it enhanced ground-based air defenses and fighters in acquiring targets, since intruding aircraft were limited in altitudes and direction; and the barrier presented a definite mental and material hazard to pilots.(30:5-7) Many think that a barrage balloon system was designed to snare aircraft like a spider web capturing unwary flies. Not so. Any airplanes caught in these aerial nets were a bonus; the real objective of the balloons was to deny the low-altitude arena to the enemy. Mindful of these capabilities, the British saw the barrage balloon as one of the ways to counter a new menace of the First World War: bomber attacks on England.

The first German Gotha bomber attacks on Great Britain occurred on 25 May 1917 at Folkestone (near Dover).(4:263) About three weeks later 17 Gothas bombed London for the first time.(4:263) This first heavier-than-air attack on the British capital shocked the nation. Raymond Fredette's The Sky on Fire described how one of the local papers viewed this violation. The Manchester Guardian called for "overwhelming supremacy in the air to redeem our shores from outrage," and added that this aerial invasion was the worst event "since the Normans conquered England." (4:126) People were definitely upset.

In response to these attacks, the British elected to use the barrage balloon, a defensive measure already employed by various countries on the continent. Germany, Italy, and France had all used aerial barriers, the former as early as 1916, and found them to be fairly effective. The Commanding General of the German Air Forces in World War I, Ernst Wilhelm von Hoeppner, praised the balloons in his book Germany's War in the Air:

As a counter-measure [to low altitude bombing] we tried the use of barrages of kites or balloons suspended in the air. The experiments lead [sic] to the establishment of air barrage units in the threatened areas. The ropes hanging down from the captive balloons were to stop the flight of the hostile plane and bring it down. Air barrages of this type were used in Luxemburg-Lorraine and in the Saar region. . . ; they afforded fine protection at night, especially against planes flying at a low altitude. The statistics of the bombing raids soon showed with what care the enemy avoided the barrages. A systematic cooperation with anti-aircraft resulted in the formation of a zone that was practically impassable by night owing to the use of the barrages at the lower levels and the anti-aircraft fire at higher altitudes.(5:93)

Like the Germans, the Italians used barrage balloons and protected Venice by mooring balloon cables on rafts.(15:99) This simple tactic was fairly successful in halting enemy low-level attacks on the city.(15:99) In fact, Austro-Hungarian aircraft gave up

low-level tactics and went to high altitude where they ineffectively bombed the target. The French installed aerial barriers to protect the steel factory at Neuve-Maisons, near Nancy. (23:Pt 3) Being so important and so close to the front, the foundry received many air attacks. But aerial activity virtually ceased when the balloons arrived. A US Army Air Corps study on barrage balloons contained an account of the effectiveness of the balloons at Neuve-Maisons:

Hardly was the section of defence-balloons organised than the attacks by air stopped. For six weeks the factories were able to work undisturbed. Then, new attempts were made, but not a single enemy aeroplane ever came nearer than two kilometres and the bombs thrown by them, to frighten rather than destroy, burst in the deserted country surrounding the inhabited areas. Up to the Armistice, not one single bomb was thrown on to the factory.(23:Pt 3)

Spurred on by balloon developments across the channel and the bombing of the capital, the British introduced their own barrage scheme in October 1917. Called the "apron," it consisted of three balloons 500 yards apart joined together by a heavy steel cable. (1:307) From this cable 1,000-foot wires hung vertically at intervals of 25 yards.(1:307) These balloons had an operational height of 7,000-10,000 feet, and 10 "apron" barrages shielded the northern and eastern approaches to the capital by June 1918.(1:307) Actually, the British planned to have 20 "aprons," but production problems and a decrease in bombings kept the other 10 from being completed. While there is no record of these balloons ever directly bringing down an enemy aircraft, they did permit the fighters and AAA to concentrate their efforts in a relatively smaller expanse of airspace (above 10,000 feet), and they barred the Gothas from flying low. The Germans found the barriers to be very effective. General von Hoepfner received a report which stated the balloons made present attacks much more difficult and would make future raids on the capital virtually impossible if balloon defenses continued to improve.(15:100) The Gotha's combat altitude was 13,000 feet. (6:166) An increase of 3,000 feet in the operational height of the barrage balloons would have effectively stopped German heavier-than-air bombardment of London. Major General Edward B. Ashmore, the London Air Defense Area Commander, valued the barrage balloon system and the services of its 3,587 personnel.(15:99) Though the barrage balloon flew for only a year in England during World War I, it was a fully integrated component of the British air defense system, performing its important mission very well.

The relative success of the barrage balloon in the First World War paved the way for its use in the Second. This time, however, instead of a mere handful, balloons would literally dot the British skyline by the thousands. Again, the balloons provided a partial solution of countering low-flying aircraft--now by faster German bombers and fighters--and of protecting vital

installations. The British belief in an integrated air defense system meant using every viable air defense weapon for self protection--a combination which included the principal means of fighters, antiaircraft artillery, and balloons.(4:8) The only modification in balloon usage from World War I concerned the "apron" concept. That idea disappeared, and single balloons were employed instead because of their faster "airborne" time and easier operation. Thus, in 1936 with war clouds darkening the horizons, the Committee of Imperial Defence authorized an initial barrage of 450 balloons for the protection of London.(2:44)

With the capital securely covered, barrage balloons also flew at fleet anchorages and harbors in the threatened areas. They were also requested to protect airfields, but there was an acute shortage of balloons during the early months of the war due to weather and combat losses as well as slow production. For instance, the 1939 Defense Plan called for 1,450 balloons, but only 624 were deployed by the outbreak of hostilities.(2:70, 74) The July 1940 goal called for 2,600 balloons, but only 1,865 were available.(2:153) However, thanks to a new balloon plant, the barrage system had 2,368 balloons by the end of August 1940 and would maintain approximately 2,000 operational balloons until the end of the war.(2:153)

The aforementioned numbers are indicative of the great value the British placed on their balloons. They even formed Balloon Command, an independent command, under the leadership of Air Marshal Sir E. Leslie Gossage to effectively control the 52 operational barrage balloon squadrons scattered across Great Britain.(2:475) Eventually, this command consisted of 33,000 men.(20:100) The amount of equipment and the number of personnel in a weapon system tell only part of the story. Performance in combat is the key, and the balloons received a thorough test during World War II.

During the Battle of Britain and throughout the course of the war, balloons proved their worth time and again. Besides protecting vital cities and ports, barrage balloons--mounted in boats--defended estuaries against minelaying aircraft. A declassified wartime report on barrage balloons stated: "Following the aerial sowing of mechanical mines, the reallocation of various units of the balloon barrage system to places like the Thames Estuary, and certain other channels, has resulted in effectively reducing the aerial mine sowing operations of the German Air Force." (28:14) Barrage balloons were also successful in hindering the Germans at Dover. There the balloon cables repeatedly frustrated enemy attempts at surprise low-level penetration.

The Dover incident deserves elaboration, because it provided, in the words of Air Marshal Gossage, "a clear indication of their [the Germans'] respect for the British balloon barrage." (15:98) In an attempt to clear the balloons from Dover, the Germans launched a major effort on the morning of 31 August 1940. They destroyed

23 balloons, losing three aircraft in the process. By that afternoon, however, 18 new balloons appeared. During the night, the Germans returned and destroyed 15 more, but the next morning the Germans found 16 new balloons. One more attack occurred that day, but only two balloons were hit while the Germans lost three more planes. Air Marshal Gossage commented on the action: "The protective balloons still fly over Dover. The attack on the barrage has proved too costly. . . . In general, major attacks on balloon barrages have ceased, the enemy having realised that the game is not worth the candle. The fact, however, that he hoped to destroy our balloons is in itself proof of the utility of the barrage."(15:98) During the height of the Blitz, 102 aircraft struck cables, which resulted in 66 crashes or forced landings.(7:102)

After the Battle of Britain, balloons continued to prove their combat effectiveness. Because of heavy losses during daylight, the Germans switched to night attacks. Defensive night fighters were still in their rudimentary stages of development which meant that guns and balloons would do most of the work against enemy bombers. Even after advances in night fighter technology, it was the opinion of London that "balloons and guns were still essential, not so much to bring the enemy down as to keep him up so that point blank bombing was impossible. . . ." (2:311) Two examples illustrated London's sentiments. First, a recently installed aerial barrage at Norwich diffused a bombing attack by forcing the enemy to attack above 8,000 feet.(2:308) Second, Exeter was severely bombed, because it had no barrage balloons to hinder the low-flying attackers. Conversely, the barrage balloons at Harwich saved that city from an attack by 17 bombers, because the Germans went after their secondary target at Ipswich-Felixstowe-- a place not protected by balloons.(2:517)

To keep the Germans off balance in their night attacks, Air Chief Marshal Sir Hugh Dowding devised the mobile balloon squadron.(13:609) According to the air chief marshal, these units would quickly deploy to threatened areas and employ their balloons "so that raiders would never know when they were safe." (13:609) Overall, balloons made a difference during the night raids on England by deterring point-blank bombing. Incidentally, it also had some tangible results. In February and March of 1941, seven enemy aircraft crashed after striking cables in various parts of Great Britain.(2:277)

Even though German aerial activity over England gradually decreased, British balloon activity did not. Balloon Command units accompanied the troops in North Africa and Italy, where they protected beachheads against low-level attack.(14:167) Four thousand balloon personnel even took part in the Normandy Invasion, crossing the channel on D-Day to protect the artificial harbors, captured ports, and ammunition dumps of the Allies.(14:167)

But perhaps the best example of "balloons in combat" occurred

during the V-1 offensive against London in 1944. Once again, balloons played an integral part of the air defense system and in this case formed the third and last line of defense against this low-flying weapon. Approximately 1,750 balloons from all over Great Britain were amassed around London, forming what one British officer called "the largest balloon curtain in history." (14:169) Although guns and fighters destroyed the bulk of V-1 weapons (1,878 vs. 1,846, respectively), the balloons were credited with 231 "kills." (7:194) Basically, that was the "last hurrah" for British barrage balloons, and as the war gradually wound down in 1945 so too were the balloons of Balloon Command.

Used on a small scale by several countries during World War I, the barrage balloon became an integral part of the air defenses of Great Britain during World War II. It provided simple, effective protection to important targets against low-level air attacks on numerous occasions. Though the actual number of aircraft forced down was relatively small, the barrage balloon's true capability was best measured by what it forced up. Aircraft encountering balloons either climbed or crashed. Flying at higher altitudes negated surprise and bombing accuracy and assisted the other air defense weapons in acquiring the target. In its simple mission during World War II, the British barrage balloon was eminently successful.

### Chapter Three

#### BARRAGE BALLOON DEVELOPMENT AND EMPLOYMENT IN THE UNITED STATES (1923-WWII)

Great Britain was not the only country interested in aerial barriers. It comes as a surprise to most Americans to know the United States had its own extensive barrage balloon defense during the early part of World War II. In fact, many areas of the West Coast had their own "balloon curtains" protecting vital cities, factories, and harbors. This chapter will discuss barrage balloon development and use in the United States from the early twenties and into the war years, highlighting the "balloon curtain" on the West Coast. It will then conclude with a look at American balloons "in combat" in the Mediterranean.

America's interest in barrage balloons started in 1923 when the Army General Staff asked the various service chiefs their ideas on using balloons for antiaircraft defense.(20:3) The Chief of the Air Service, Major General Mason M. Patrick, responded positively, stating in his letter:

I believe the barrage balloons are an effective and comparatively cheap method of increasing the protection of such places as the Panama Canal, the Capitol. . . ,

important bridges, viaducts, dry docks, and wharves, etc., where it would be necessary for bombers to fly at altitudes less than 15,000 feet in order to accurately bomb small targets.(20:85)

The Army General Staff responded favorably and directed the Air Service to start testing. Historic Langley Field, Virginia, received the first barrage balloons for tests in the spring of 1927.(20:8) The first two flights ended in failure--with one balloon breaking its cable and drifting out to sea--but the third succeeded after several modifications. Unfortunately, interest and money in the barrage program waned steadily, and by 1930 balloon experimentation ended for nearly 10 years.(20:9) It would take a real stimulus to revive interest in the barrage balloon program. Fortunately, fate provided two: a man called Hap Arnold and the war in Europe.

General Arnold, who later became Chief of the Army Air Force in World War II, did two things. He called for a series of meetings, and he directed Maxwell Field, Alabama, to study the question of balloon barrages. In these meetings (30 August and 2 September 1937), which could be considered the first official barrage balloon conferences, General Arnold asked for the advice of the various service chiefs regarding employment of these balloons.(20:16) As might be expected, only the Air Corps expressed interest in the gas bags, and General Arnold decided the barrage balloon experiments would be carried on by that branch using its own research and development funds. The Air Corps allotted \$5,000 for the purchase of one balloon with experiments to begin in 1938.(20:17) That year also produced the Maxwell Field report earlier requested by Arnold. Entitled "Study No. 40: Employment of Balloon Barrages," it advocated the further development of these aerial barriers stating: "Balloon barrages are capable of providing protection against air attacks and are of tactical value as a means of anti-aircraft defense." (23:9) Two types of balloons would be designed: one for high altitude (6,000-20,000 feet) and one for low (up to 6,000).(23:10) "Study No. 40" provided the United States its first basic barrage balloon doctrine and proved to be vital as war approached closer to America.

The invasion of Poland and the declaration of war on Germany by Great Britain and France provided the second stimulus to the barrage balloon idea. This time the War Department gave its complete blessing to the project and launched an extensive program in 1940. The plan called for 4,400 operational balloons (of which 3,400 were to be the low-altitude type) to be distributed as follows: 2,200 for Northeast Air District (industrial United States), 800 for the West Coast, 200 for Panama, 200 for Hawaii, and the rest at other strategic locations in the United States.(20:25) (It is interesting to note that the vast majority of balloons were situated to cover the Atlantic Coast. War with Germany looked more probable than war with Japan.) These 4,400 balloons would be

ready by 1 January 1943, but as events would show, these balloons were over a year too late.

The attack on Pearl Harbor launched the military into action. Because of the obvious weakness of our air defenses on the West Coast--only 10 bombers and 45 modern fighters existed to defend 1,200 miles of coast--what balloons were available were hastily dispatched there.(29:119) There existed the clear possibility of more carrier-borne attacks on US soil, and the din of Japanese submarine activity off the Pacific Coast gave credence to that belief. From 20-24 December 1941 the Japanese torpedoed four US ships off the Western Seaboard with the freighter Absaroka hit only six miles off California.(22:98-99) To protect our crucial assets from what seemed to be imminent air attack, balloons mushroomed around important areas in California, Washington, and Oregon. The "History of the 4th Antiaircraft Command" stated the importance of this area and barrage balloon usage:

So vital were the airplane plants of the Pacific Coast that authorities in Washington felt the inadequate air defense of these plants should be supplemented in every way practical. Balloon barrages were therefore provided to defend vital areas in the absence of fighter or antiaircraft defense, to supplement defenses during weather when fighters could not operate or when AA artillery gunners could not see, and to constitute a menace to enemy dive-bombers or strafers in case of a surprise attack.(22:135)

On January 1942 the first barrage balloon battalion arrived at Seattle to provide balloon protection for the Western Shore. General George C. Marshall, Army Chief of Staff, considered the defense of the Pacific Coast so important that he personally inspected the area in early April 1942 and ordered additional barrage balloon units to the West Coast.(22:141-142) By June 1942 there were a total of six battalions guarding this important area, but the Fourth Antiaircraft Command "estimated that 18 were needed to adequately protect the airplane and navy installations at Seattle-Bremerton (4), the Portland Area (1), San Francisco-Sacramento-Mare Island (6), Los Angeles-San Bernardino Area (6) and the San Diego Area (1)." (22:143) Though the United States never did match the scope of British balloon operations, by August 1942 it did produce a total of 10 US Army balloon battalions. Six of these (with approximately 430 balloons) protected the West Coast while one was at work in the Northeast United States.(22:153) The other three battalions were "out in the field" with two in Panama and one in Hawaii.

The tremendous growth of the barrage balloon program during 1942 was matched by its rapid decline a year later. In summer 1943 the War Department ordered the termination of the balloons on the West Coast, citing that better fighter and antiaircraft defenses

and a reduced likelihood of Japanese aerial attack on that area made the balloons unnecessary.(22:162) However, the Commanding Generals of the Western Defense Command, the Fourth Fighter Command, and the Fourth Antiaircraft Command (those commands protecting the West Coast) objected strongly, stating the balloons on the Pacific Coast were "an essential and integral part of the air defense" (22:C-20) and that they should "be left in place and continue to operate as at present." (22:C-20) The War Department prevailed, however, and on 18 August 1943 the six balloon battalions ceased operations.(22:162) Surprisingly, the War Department deemed the barrage balloons important enough to send overseas into combat and in late 1943 deployed several Army balloon units to the fighting in the Mediterranean. Since these were the only US Army balloon units to experience combat, a brief summary of their activities is necessary.

The North African Campaign covered a fairly large front, and, as expected, many areas lacked sufficient air defenses. Balloons provided protection to several important ports, effectively enhancing the existing antiaircraft defenses. For example, in August 1943 the Air Defense Region protecting Oran, Algeria, "requested 60 balloons for its sector in order to discourage torpedo, dive bombing, and low level bombing attacks." (24:87) By October 1943, three American barrage balloon batteries (each with 45 balloons) operated in various ports in North Africa and Italy.(24:87) When the port of Naples was captured, a battery of balloons operated here as part of the overall protection of that vital harbor from air attack. Naples was crucial to Allied operations in Italy. The AAF Air Defense Activities in the Mediterranean history stated: "Among these ports Naples was the most important in the Allied line of communications; during January 1944 the port handled more tonnage than any other port in the world with the exception of New York." (24:103) Though it was close to the German lines and received many air attacks, Naples had a solid air defense system and suffered only slight damage.(24:104) A Fifth Army AA officer mentioned in the above report that a good port defense consisted of seven factors--with one of those requirements being barrage balloons in depth.(24:104) The AAF Air Defense Activities in the Mediterranean summarized balloon operations in that theater: ". . . although American barrage balloons were not of primary importance in the Allied air defense system, they were undoubtedly valuable as a supplementary device to fighter aircraft and AA." (24:88)

American barrage balloon development during the twenties and early thirties was lackadaisical at best. It took the strong leadership of General Arnold and the threat of war in Europe to bring the barrage balloon concept to fruition. The attack on Pearl Harbor added an extra goad, and by mid-1942 several hundred balloons protected the West Coast and vital installations in Hawaii and Panama. Several Army balloon units went overseas to the Mediterranean and effectively protected vital ports against low-level attack, complementing the other air defense measures. And like the

British, American balloon usage gradually disappeared as the war drew to a close.

## Chapter Four

### BARRAGE BALLOONS: THEIR APPLICABILITY TODAY

The British and American experiences with barrage balloons point out two major facts: The low-level threat is a problem, and barrage balloons can aid in countering that threat. Therefore, it is rather surprising the concept of aerial barrages has remained lost in the history books. The lessons of two world wars, especially the second, show that barrage balloons are ideally suited for low-level air defense. Balloons are just as applicable today as they were back in the forties and can effectively complement the SAMs, rapid-fire AA guns, and fighters of the modern air defense system. This chapter will discuss the use of barrage balloons to protect one of NATO's vital assets--the airfield. Specifically, it will look at the origins of this concept before examining the advantages and disadvantages of using balloons in this untried role.

One of the most important installations in NATO is the airfield, which many have called the Achilles Heel of air power. The Soviets fear US and Allied aerial might and will do everything possible to destroy it quickly and completely. Therefore, a mass low-level attack on NATO air bases, as described in the first chapter, is a certainty. Such vital targets deserve extra protection and barrage balloons offer that capability. Based on barrage balloon usage during World War II--when they successfully defended ports and factories from low-level attack--it seems a logical progression to employ aerial barriers today to protect the airfields of NATO. Squadron Leader P. D. John of the RAF emphasizes this idea in his insightful 1984 article "Aerial Barriers to Enhance Airfield Defences." However, defensive balloons for air base protection were seriously considered by the United States Air Corps Tactical School as early as 1935.

The Air Corps Tactical School at Maxwell Field, Alabama, was the intellectual center for the study of air power. Home of the well known strategic bombing concept, it was also the birthplace of using barrage balloons for air base defense. In 1935 the commandant of the school asked the Chief of the Air Corps for "the delivery of a barrage balloon and necessary equipment to Maxwell Field for use in the development of an effective defense for flying fields in event of attack by enemy aircraft." (20:12) This was the first mention of balloons to protect air bases, but this novel idea quickly died due to lack of funds and high-level interest. In 1938, however, interest in aerial barriers grew because of the threat of war in Europe. In that year the Air Corps Tactical School produced a detailed report entitled "Study No. 40:

Employment of Balloon Barrages." Of the various ways to employ the balloon, the report emphasized its use for air base defense against low-level attack: "the low altitude balloon . . . is suitable for use in the protection of airdromes, aircraft on the ground and air base facilities." (20:9) The report mentioned balloons for protecting "airdromes" several more times, but regrettably this concept remained dormant until 1943.

A brief flicker of interest occurred in March 1943 when Brigadier General Saville, Commanding General of Antiaircraft Command, asked for tests using barrage balloons for air base defense: "It is believed that very low altitude barrage balloons may have excellent possibilities in the defense of airdromes and that these possibilities should be investigated." (27:4) Two months later General Saville organized a conference to discuss this idea, and the general consensus was that balloons demonstrated "definite promise of Airdrome Security." (27:1) The minutes of the meeting stated: "As far as altitude is concerned, the effectiveness of Boufors [sic] at low. . . altitude shows that below 200' is our big problem. VLA blns [Very Low Altitude balloons] fill the gap from the ground to 500'." (27:1) Initial VLA balloon tests actually occurred at Orlando, Florida, in September 1943, but testing ceased after only a few flights. The testing unit reported that "there was a definite de-emphasis respecting both the low-altitude and the very-low-altitude barrage balloons." (21:7) (The reader will recall the War Department's directive to stop balloon operations in the West Coast effective August 1943.) Thus, the concept of using low-altitude balloons to "fill the gap" in air base defenses virtually disappeared.

Though last considered in 1943, the idea of using balloons to protect airfields is still viable even today. The barrage balloon offers several distinct, proven-in-wartime advantages: It denies the low altitude to enemy aircraft, enhances air defense systems, and presents a definite mental and material hazard to the enemy pilot.

Strategically placed, balloons can easily and effectively deny the low-altitude arena to the attacker. Three locations warrant balloon placement. Of special attention would be the suspected ingress routes located at some distance away from the airfield.(16:45) Valleys, mountain passes, rivers, and canals are only a few sites where barrage balloons could be effectively placed at altitudes ranging from 300-1,000 feet. Next, some balloons would be placed closer to the air base in small irregular groupings. Squadron Leader P. D. John states: "A staggered pair of lines, or small groups of randomly positioned balloons, would provide a better obstacle than a single line of closely-spaced balloons. . . ."(16:49) His observation is borne out by history. Balloons sited at irregular intervals and altitudes make better barriers.(7:102) Conversely, an orderly arrangement of rows of balloons at uniform alti-

tude makes them easier to outflank or overfly. Finally, other balloons would be positioned throughout the air base itself. Since the Warsaw Pact lacks large numbers of stand-off weapons, their aircraft must overfly the target to deliver their bombs.(16:40) This last balloon emplacement should prove to be especially disruptive to the attackers. The blockage of ingress routes and the placement of other balloon barriers between the attacker and the target force aircraft higher, denying them the safety and surprise of low altitude.

With the attacking aircraft forced higher, the balloons then provide almost simultaneous force enhancement. Active air defense weapons receive early warning and ready their weapons, taking advantage of the fact that balloon positions and altitudes are known. As described in the first chapter, SAMs and other weapons will be only partially effective in the ultra-low, almost supersonic melee over the airfields. An aircraft forced higher is an aircraft closer to destruction. In addition, the balloon obstacles would divert the flyer's attention from his target, causing him to either inaccurately bomb his objective or to make another pass.(16:45) Another attack, of course, increases the probability of acquisition and destruction by a SAM.

But perhaps the most important capability of the barrage balloon--at least in the mind of the attacking pilot--is the definite mental and material hazard the cable presents to him and his aircraft. During World War II, aerial cables did destroy aircraft, but the threat of hitting a cable was almost as nerve racking. In Berlin Diary William Shirer wrote of a German pilot who, during the night bombing of London, always dropped his bombs too high--he feared the barrage balloons at lower altitudes.(10:516) Allied pilots felt the same way about cables. A declassified World War II intelligence bulletin stated: "In 1940, the RAF was encountering an increasing number of barrage balloons over their bombing objective in western and northwestern Germany, and these balloons were a major cause of worry to RAF pilots." (26:16) An American pilot echoed the same feelings in another declassified report:

. . . unknown balloon cables are a very considerable mental hazard, regardless of anyone's ideas to the contrary. The undersigned had the opportunity to fly a Hurrican [sic] II out of a balloon-defended factory field last week, and in spite of having a corridor cleared by lowering one balloon, the mental reaction against all the remaining cables was distracting. Later on, during the same journey, when bad weather was encountered near Birmingham, the same cable worry was present. It is not believed that hostile aircraft will knowingly come down within close range of a balloon barrage.(28:14)

In addition to the three main capabilities discussed above,

aerial barriers provide two other advantages: low cost and durability. Wallop Industries of Great Britain has developed a barrage balloon called the Skysnare.(18:687) The price for a barrage of six balloons is approximately \$18,000 (in 1984 dollars) with the cost of maintenance and training equally low.(16:49-50) The only "fuel" for the system would be the helium or hydrogen gas to lift the balloon. The cost effectiveness of the balloon is considerable, especially when one considers the cost of modern weapon systems and ammunition. The attractiveness of the low cost of the balloon is matched by its durability. Made up of a cable, a single-ply plastic envelope, and a winch, the balloon is extremely robust. It can remain airborne for up to two weeks per inflation.(31:--) Skysnare balloons use a 4-millimeter Kevlar cable, giving the system extraordinary strength and destructive power should an aircraft strike the cable.(31:--)

The advantages of the barrage balloon are many, but like any weapon system there are drawbacks. Extremely high winds are bad for balloons. During the Battle of Britain, one heavy gale destroyed or damaged approximately 250 balloons.(28:14) The same mishap occurred in the United States in 1942 when 57 balloons broke loose in a heavy storm and caused substantial damage to the Seattle area.(22:146) In each case the balloons flew at their operational altitudes. This practice stopped in America. Balloons were hauled in when storms approached. However, in Great Britain they were only lowered, which accounted for many losses. The fear of German aircraft was still too great to "bed down" the balloons. Timely weather reports will aid balloon operations. A second disadvantage of the balloon is the navigation signal it sends to the enemy. If balloons are encountered, then the target area must be nearby. This drawback was partially corrected in World War II. The balloon and the "balloon bed" were camouflaged.(22:157) In addition, the balloon itself was hidden in the clouds with only the near-invisible cables showing. (This technique makes the balloon excellent for work in the typically overcast European theater.) On clear days there is a problem, but this is more than offset by the deterrent value of the barrage. The last negative of the balloon concerns the hazard it presents to friendly aircraft. Cables do not discriminate. However, Squadron Leader P. D. John suggests using "procedural control" to reduce the chance of a friendly aircraft hitting a cable.(16:51) This method worked very well during World War II when hundreds of friendly planes safely negotiated aerial barriers. The barrage balloon is a very effective system with several distinct advantages for air defense.

The concept of using barrage balloons to protect airfields had its origins in the mid-thirties at the Air Corps Tactical School at Maxwell Field, Alabama. It was a novel idea, but interest virtually disappeared after a few tests in late 1943. The barrage balloon, however, is still an ideal weapon for air base defense. It offers effective denial of low-altitude airspace while enhancing other air defense weapons. The cable, in particular, is a serious

threat to any aircraft. Other advantages include its low cost and durability, an attractive bonus in an already too expensive arms market. The disadvantages concern the balloon's susceptibility to high winds and the navigational signal it might provide to the enemy. In addition, the cable presents a hazard to friendly pilots. However, looking holistically at the modern barrage balloon, the advantages far outweigh the drawbacks. The barrage balloon is a capable defensive system, offering the West an effective low-tech weapon against a high-tech threat.

### Conclusion

In the search to build a better mousetrap, the lessons of history are often neglected. Technology has produced a marvel of engineering in the modern fighter plane, enabling it to fly higher, faster, and lower than ever before. But advances in the aircraft were matched by advances in the antiaircraft weapon with each seeking to counter the other. In the modern battle the jet fighter's forte is high-speed, low-level air assault, a form of attack difficult to combat. Defensive weapons have responded with highly advanced SAMs, but SAM success at low level is problematic as demonstrated in the Falkland Islands War. More technology always seems to be the answer. However, a simple solution to help counter the low-level threat is the barrage balloon.

Barrage balloons were developed in World War I to counter the most advanced technological threat of the day--the airplane. The Gotha bomber, which raided the southeastern English countryside from 1917-1918, represented the apex of German aircraft engineering skill. But this airplane was effectively denied direct and easy low-level access to the target by a balloon and a wire. Though no enemy aircraft were known to have been destroyed by the barrage balloons over England, the barrier did hinder German aircraft operations by confining their attack options to above 10,000 feet. This limitation made it easier for antiaircraft guns and fighters to destroy the aerial invaders.

Balloons again found prominence during World War II and performed well in this combat-rich environment. That the British used over 2,000 balloons manned by 33,000 men is indicative of their belief in its capabilities. This belief was shared by the United States. During the war, nearly 430 balloons protected the West Coast alone. Several Army balloon units saw "combat" in North Africa, providing effective protection against low-level attack on captured ports.

Barrage balloons disappeared after World War II, but their capabilities--proven in war--deserve to be used again today. Naturally suited to defend small, important areas, barrage balloons offer ideal protection for NATO's vital airfields. Here balloons

can offer both tangible and intangible benefits. Expertly positioned, they provide a real hazard to enemy aircraft, forcing them up or around into awaiting SAMs. Chances of surprise attack and low-level approach are reduced. The intangible concerns the presence of the balloon itself. It makes the enemy think twice about trying to destroy a balloon-protected target. Barrage balloons are not a cure-all, but used in conjunction with other air defense systems, they offer significant weapons enhancement. Colonel Turley, an American barrage balloon advocate during World War II, emphasized the team approach to air defense in his article "Barrage Balloons." Written in 1942, his observations are as current now as they were back then:

When employed alone, barrage balloons ordinarily would not be effective. . . . In conjunction with other arms, barrage balloons constitute an element in the antiaircraft defense system complementary to antiaircraft artillery and pursuit aviation, the balloons being most effective at low altitudes where the complementary arms are least efficient. If maintained at effective strength in spite of losses of balloons from storms, friendly antiaircraft fire and enemy action, barrage balloons constitute a dependable and ever ready defense against low-flying aircraft.(19:21-22)

Simply stated: Barrage balloons optimize air defenses.

While technology changes, some things always remain the same. A balloon and a wire deterring a Gotha over London 70 years ago can equally deter a Fencer over Bitburg in the future.

---

## BIBLIOGRAPHY

---

### REFERENCES CITED

#### Books

1. Cole, Christopher and E.F. Chessman. The Air Defence of Britain 1914-1918. London: Putnam Press, 1984.
2. Collier, Basil. History of the Second World War: The Defence of the United Kingdom. London: Her Majesty's Stationery Office, 1957.
3. Ethell, Jeffrey and Alfred Prince. Air War South Atlantic. New York: Macmillan Publishing Company, 1983.
4. Fredette, Raymond H. The Sky on Fire: The First Battle of Britain 1917-1918 and the Birth of the Royal Air Force. New York: Holt, Rinehart and Winston, 1966.
5. Hoepfner, Ernst Wilhelm von. Germany's War in the Air. Leipzig, Germany: A.F. Koehler, 1921.
6. Hogg, Ian V. Anti-Aircraft: A History of Air Defence. London: Macdonald and Jane's Publishers Limited, 1978.
7. Jackson, Donald Dale. The Epic of Flight: The Aeronauts. Alexandria, Virginia: Time-Life Books, 1980.
8. MacMillan, Norman. The Royal Air Force in the World War: Vol. IV, 1940-1945. London: George G. Harrap & Company. Ltd., 1950.
9. Martin, Laurence. NATO and the Defense of the West: An Analysis of America's First Line of Defense. New York: Holt, Rinehart and Winston, 1985.
10. Shirer, William Lawrence. Berlin Diary: The Journal of a Foreign Correspondent 1934-1941. New York: A.A. Knopf, 1941.

## CONTINUED

11. Watson, Bruce W. and Peter M. Dunn (eds.). Military Lessons of the Falkland Islands War: Views from the United States. Boulder, Colorado: Westview Press, 1984.
12. Windrow, Martin and Dennis Baldry (eds.). Battle for the Falklands (3): Air Forces. London: Osprey Publishing, 1982.

### Articles and Periodicals

13. "Balloon Barrages." Flight, Vol. 32, (October-December 1937), pp. 608-609.
14. Delderfield, R.F., Flight Lieutenant, RAF. "A Study in Passive Defence." The Royal Air Force Quarterly, Vol. 16, No. 3 (December 1944-September 1945), pp. 164-169.
15. Gossage, Leslie, Air Marshal, RAF. "Balloon Command." Flying and Popular Aviation, Vol. 31, No. 3 (July-December 1942), pp. 97-100.
16. John, Peter D., Squadron Leader, RAF. "Aerial Barrages to Enhance Airfield Defences." The Hawk: The Independent Journal of the Royal Air Force Staff College, (March 1984), pp. 39-51.
17. Poechhacker, Christian. "Low Level Air Defence Aircraft Hunters: A Critical Survey of Modern Man-Portable Surface-to-Air Missile Systems." Defence International Update, No. 70 (April 1986), pp. 10-17.
18. "Tethered Anti-Aircraft Balloon." International Defense Review, Vol. 20, No. 5 (1987), p. 687.
19. Turley, R.E., Colonel, USA. "Barrage Balloons." Coast Artillery Journal, Vol. 85, No. 1 (January-February 1942), pp. 20-24.

### Official Documents

20. Army Air Forces Historical Study No. 3. Barrage Balloon Development in the United States Army Air Corps 1923-1942. Historical Research Center, Maxwell AFB, Alabama: 1943.
21. Army Air Forces School of Applied Tactics. History of the 851st Composite Coast Artillery Battery (AA) 28 September 1942-19 October 1943. Historical Research Center, Maxwell AFB, Alabama: 1943.

## CONTINUED

22. Fourth Air Force. History of the 4th Antiaircraft Command 9 January 1942 to 1 July 1945, Vols. I and V. Historical Research Center, Maxwell AFB, Alabama: 1945.
23. Report Of The Air Corps Board. Study No. 40: Employment of Balloon Barrages. Historical Research Center, Maxwell AFB, Alabama: 1938.
24. United States Air Force Historical Study No. 66. AAF Air Defense Activities in the Mediterranean 1942-September 1944. Historical Research Center, Maxwell AFB, Alabama: 1954.

### Published Proceedings of a Conference

25. Lessons of the South Atlantic War. Proceedings of the Conference on the Anglo-Argentine War of 1982. October 1982. Washington, D.C.: Defense & Foreign Affairs Ltd., 1982.

### Unpublished Materials

26. Air Forces General Information Bulletin No. 7. "British & German Balloon Barrages." A declassified report on said topic, Historical Research Center, Maxwell AFB, Alabama, December 1942.
27. Conference at AAA Division, Orlando, Florida. "Test of Barrage Balloons in Airdrome Defense." Minutes of a meeting on said topic, Historical Research Center, Maxwell AFB, Alabama, 13 May 1943.
28. Robinson, G.N., 1LT, United States Army Air Corps. "Barrage Balloons." A declassified extract from reports of United States military personnel stationed abroad concerning barrage balloons, Historical Research Center, Maxwell AFB, Alabama, 1941.
29. Scrivner, John H., Capt., USAF. "The Military Use of Balloons and Dirigibles in the United States 1793-1963." Master's Thesis, University of Oklahoma, 1963.
30. Tactics Department of the AAA School. "Notes for AA Tactics, Pamphlet No. 20, Barrage Balloons." A declassified pamphlet concerning barrage balloons, Historical Research Center, Maxwell AFB, Alabama, 15 June 1943.

## CONTINUED

### Other Sources

31. Wallop Systems Limited. "Rampart Low Level Defence System,"  
London. Advertisement, 1987.

END

DATE

FILMED

6-1988

DTIC